Orbit®

3+1 PROPORTIONAL

$1.00

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Orbit 3 + 1 Proportional Radio Control System

Owner's Installation and Operation Manual

& Tips For Rigging and Flying Proportional

Controlled Model Aircraft * by Dick Riggs

The ORBIT 3 + 1 proportional sets a new standard of reliability and flexibility of operation in the radio control field. It offers you the utmost in convenience and the maximum economy. You can begin by using the 3 + 1 for simple rudder only and later progress to all four controls for "Full-house" multi-competition.

System Operation

The two primary flight controls, right and left rudder and up and down elevator, are operated by two alternating audio tones. Movement of the control stick produces a change in audio tones above and below the neutral frequencies of 1750 and 3500 cycles.

3500 cycles neutral on the directional rudder channel. Displacement of control stick to the right raises the tone and causes proportional movement of the rudder. Stick motion to the left lowers tone frequency causing servo response in opposite direction.

An up movement of the control stick results in proportional "up-elevator," and down produces "down-elevator," in similar fashion. Electronically lowering tone from the neutral at 1750 cycles produces up control, and raising frequency produces down.

These two tones are not transmitted simultaneously, but in separate alternating segments. That is, one tone is sent for a short period, and then the other. These tones are repeated at a varying rate of from approximately 20 to 40 cycles per second. This varying RATE of tone repetition produces the throttle command. The lowest rate is low-speed; the highest rate moves the throttle servo to the high-speed position. The throttle lever on the transmitter allows completely proportional control of engine r.p.m. from idle to full throttle. This permits an infinite variation of throttle position rather than incremental settings offered by some systems.

Transmitter

On the right hand side towards the top of the transmitter are two black knurled knobs, see Figure I. The knob closest to transmitter face is trim on directional, or rudder, channel. Rotation of the knob produces a small degree of servo excursion to right and left of neutral. Clockwise rotation is right trim; counter-clockwise is left. The rear knob is elevator trim; clockwise rotation of this knob is down trim; counter-clockwise is up trim.

The lever on the side of the transmitter just below the two trim knobs is the throttle control. This lever operates through a horizontal plane with push towards face of transmitter as fast, and pull to the rear as slow.

The single stick on the face of the transmitter contains the primary control functions. Horizonal movement to right and left is directional control, while up and down motion is elevation. This is a true gimbal assembly and may be moved full circle for simultaneous control. ON/OFF switch is to the left of the control stick and operates in the conventional manner.

Transmitter power is provided by a nine volt Eveready No. 276, or RCA No. VS306 battery or equivalent. Male and female snaps are provided on transmitter power leads to mate to appropriate terminals on specified batteries. This battery will provide thirty- to forty-hours of operation depending on original condition of battery and degree of usage. Replacement is recommended at 7.5 volts. *Do not operate below 7.2 volts.* When a dry-cell battery drops below 1.2 volts per cell its reliability is extremely suspect.

Receiver

The Orbit 3 + 1 receiver incorporates the well-proven "twin-deck" construction. This method provides the smallest possible size and weight with maximum strength. The R/F section is a superheterodyne circuit insuring maximum sensitivity and adjacent channel rejection. Special test

Fig. 1

equipment is required for proper alignment of this receiver; "field" adjustments must NOT be attempted. Audio frequency discriminator cup-cores are factory pre-aligned and "fixed" with a special epoxy glue. UNDER NO CIRCUMSTANCES SHOULD ADJUSTMENTS TO THESE CORES BE ATTEMPED. A subsequent section will detail procedures for matching transmitter tones to receiver/servo combo for neutral, linearity of throw and proper degree of servo throw.

Servos

These units are based on a reliable, tested mechanical design with more than adequate power for surface control on large, fast models. The high efficiency motor will start and run on as little as 12 to 15 milliamperes of current. The amplifier circuit employs selected germanium and silicon semi-conductors for stable operation, while a built-in feed-back potentiometer provides true "closed-loop" design. Servo transit time is half a second from maximum to maximum, based on ninety degrees of feedback potentiometer rotation. This gives a total of eleven-sixteenths of an inch of push-rod travel.

Battery Pack

The recommended, factory-supplied battery pack is a special unit, consisting of four 600 Milliampere-Hour capacity nickel-cadmium, sintered plate, cells of a "pen-cell' configuration. The charger supplied will bring cells to full capacity from discharge in approximately 18 hours. This pack will easily yield aggregate flight-time of two hours, and with its flat, thin shape, is convenient for installation. As an alternative, any pack of four nickel-cadmium cells to as low as 250 Milliampere-Hour capacity may be used, with a corresponding decrease in aggregate flight-time.

250 MAH cells, for example, could be used in a pylon-racer where small size and weight are at a premium, and total flight-time is low. On a fully charged 250 MAH pack, approximately eight flights of pylon duration should easily be possible and still provide a safety margin. Assuming that most competition pylon racing airplanes do not utilize motor control, it is good practice to leave the throttle lever in the high speed position. This condition keys the primary tones at the fast rate and tends to lower the overall current drain of the receiver/servo combination.

Installation

The Orbit 3 + 1 receiver is not subject to vibration in the same manner as reed equipped receivers. However, sufficient sponge or foam padding should be used around the receiver to isolate the unit from high amplitude vibrations to eliminate the possibility of mechanical failure of components, and to absorb the shock of "hard-landings." The most delicate component used in superheterodyne receivers is the crystal, and some caution and care is necessary to prevent a "cracked" crystal. If possible, use as much padding as is normally used in reed receiver installation, which is to say, as much as possible. Don't allow the corners of receiver to touch any part of the fuselage, or ride against such things as push-rods, wires, or servos.

These same cautions should be exercised when installing the battery pack. High amplitude vibration and severe shock can cause mechanical failure of batteries. Always wrap your pack in sponge, and do not allow it to ride solidly against any portion of the vehicle in which it is installed.

Servo installation is self-explanatory and, in any case, depends on the physical nature of the vehicle involved. These units may be mounted in any position utilizing the integral mounting flanges on the servos. Brackets may be fabricated from either metal (i.e., .040 to .050 aluminum) or plywood to suit. Self-tapping sheet metal screws #4 by ½-inch long are excellent for use through the rubber grommets. Use a #4 flat washer between the head of the screw and the grommet. Do not over-tighten screws. Rather, pull snug or just to the point where grommet begins to flatten and then "set" the screws with a small dab of Walthers "GOO" or any contact cement. Model glue can be used for this purpose, but it tends to crack loose.

It must be stressed that minimum friction and bind in control linkages is very important. Adjust all surfaces and linkage so they will fall freely from side-to-side of their own weight. In severe cases, binding controls cause higher than necessary current drain, and could result in "jerky" response.

Note that direction of servo travel is non-reversible. That is, it is not possible to reverse direction of servo rotation by switching wires. If control is backwards, it is necessary to shift the pushrod to the opposite side of the control wheel. It is also necessary to provide a slight spring tension for the throttle-control servo to work against.

The full low-speed position with transmitter ON is not the same as "full-safe" low-speed. With transmitter OFF, the throttle servo will rotate approximately twenty degrees farther than full closed position of throttle with transmitter ON. It is for this reason that a solid bind in the motor control linkage must be avoided. One good method is to use .040 wire for the pushrod with a small "V" somewhere in its length to act as a spring.

Fourth Control

Although this is a three-channel system, note that the servo plug block from the receiver has facilities to accept four servos. Each of the brown wires connected to this block will operate a servo from the directional channel. This means that the fourth servo could be used as aileron or rudder, giving CAR action (coupled aileron and rudder), because the two servos involved would then operate simultaneously. In the past, CAR has proven to be a simple, effective means of achieving the benefits of both aileron and rudder action with a minimum of complexity.

If you desire to use this system, some experimentation is necessary to determine the proper relationship of aileron to rudder throw. It is generally best to begin with a minimum amount of rudder action and increase in incremental steps until rudder yaw becomes excessive. Bear in mind that a high-wing configuration will respond nicely to rudder control and will accept greater travel with less apparent yaw than low-wing airplanes.

The low-wing configuration responds better to aileron action for directional control because yaw becomes pronounced very quickly. This reaction becomes even more evident as airspeed increases, so rudder throw should be minimum. As stated, some experimentation is necessary to determine the proper rudder movement.

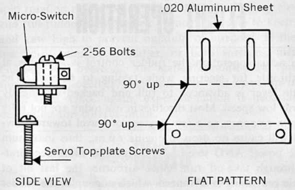
In the "Full-house" competition multi-control model, rudder is generally used only at low airspeeds. For example, it is used for the three turn true spin, the wing-over (or stall-turn) and for maintaining directional control during the vertical ascent approach to the tail-slide. Because low airspeeds are involved, it follows that a large degree of rudder throw should be available to maintain precise control. Also, it is usually necessary to have a very large rudder with extreme throw to force the generally too-stable model into a true spin.

The low-wing ship so rigged would suffer from extreme yaw at higher air-speeds and would present an unsatisfactory flight appearance. It would also probably be difficult to fly. The solution lies in being able to select rudder command at will.

The following paragraphs describe a simple method of doing so even though only three channels are available. Additional materials required for this modification are: 2 ¼-watt 2000 (or 2.2K) ohm resistors, and a small micro-switch which has a common connection to a normally closed and a normally open contact. A small scrap of metal (.020 aluminum or tin can stock).

Mount the micro-switch to the throttle control servo, see figure 1. Figure 1A shows a flat pattern of the micro-switch mounting bracket and a side view of the switch mounted on the bracket. The bracket is attached by two of the servo top-plate retaining screws. Figure 2 shows the wiring of the micro-switch. The dotted lines indicate micro-switch, with rudder in UN-coupled condition.

The recommended operation sequence results in coupled aileron and rudder at low-speed to slightly below full-throttle. Through the last few degrees of throttle servo travel, the rudder servo is uncoupled, and referenced back to the resistor center-tap. With the micro-switch in the normally-closed position, the signal wire from the receiver is tied to the input wire of the rudder servo. This results in the CAR mode because the aileron is never disconnected. As the throttle servo advances to full high-speed, the micro-switch is energized to the Normally Open contact, referencing the rudder servo signal wire to a voltage divider through the 2200 ohm resistors, driving rudder servo to neutral.



MICRO-SWITCH MOUNTING BRACKET

Fig. 1 **Fig. 1A**

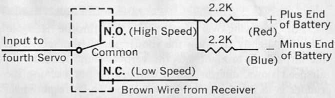


Fig. 2

FLIGHT OPERATION

In actual operation the rudder control is available at low throttle for steering while taxiing to take-off. The throttle lever is advanced to full and backed off slightly towards low speed. Most throttles in use today are not fully linear in response, so a few degrees of travel towards low-speed will cause no drop in engine r.p.m., thus maximum engine power AND steering are available while accelerating through take-off run. Once airborne, the last bit of throttle remaining is advanced, which uncouples the rudder servo and allows normal aileron/elevator control for flight.

Wing-Over

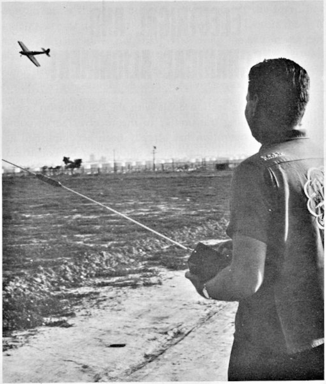
For the wing-over (stall-turn) the throttle is again retarded slightly to bring the rudder servo into service as the airplane is brought into the vertical climb attitude. As airspeed slows, aileron action diminishes, but because the rudder is in the slipstream of the propeller, its response remains good. It becomes a matter of timing to let the airspeed fall sufficiently to negate aileron action as rudder is pushed hard over to complete the 180° change of direction to the vertical dive attitude.

Tail-Slide

Conditions for the tail-slide are the same in that the airplane is brought into the vertical climbing position with throttle reduced slightly so rudder is coupled. The rudder is used primarily in this maneuver to maintain a straight heading to the moment of stall, when throttle is pulled to full low-speed allowing the airplane to back down. At this moment, *all* controls are aerodynamically ineffective and the airplane is on its own until flying speed is recovered.

True Spin

The true spin in generally best approched by reducing throttle to the minimum and then slowly pulling in "up" elevator until all flying speed is lost before applying full rudder. Do not let the nose rise too high because a forward "scallop" builds some airspeed and restores effectiveness to the ailerons. If full rudder is induced at the right moment, the resulting massive yaw will cause complete stall of the



"inside" wing panel, and the aircraft will drop into true spin rotation regardless of aileron attitude. Full up elevator and full rudder must be held through the spin to keep drag and yaw high to prevent build-up of airspeed. If there is insufficient control of either, or both surfaces, airspeed build-up will overcome the stalled condition (or prevent spin entry altogether), and the spin will open up into a spiral dive. Once again, experimentation is necessary to determine the correct ratios.

BOATS

The Orbit 3 + 1 is ideal for use in boats. The simultaneous and instantly selectable throttle setting is of definite advantage for precise handling and maneuvering. This is particularly beneficial for high speed runabout or hydro hulls. Because of the large speed range of this type of boat, rudder effectivity varies greatly. With proportional rudder available, it is only necessary to apply as much control as is needed at the *rate* which the situation demands. Because throttle control is instantly available at the same time rudder may be in use, a high degree of precision in handling is possible. Complete control of rudder throw allows maneuverability of a high order.

One word of caution, the engines used in boats, particularly high-speed types, operate in a very high r.p.m. range. They operate in a range much higher than generally encountered in model aircraft. This can result in very high vibration amplitude and G force accelerations. The 3 + 1 super-heterodyne receiver must be very carefully installed, preferably in sponge *rubber,* to insulate it against possible mechanical failure of components caused by severe vibration.

The receiver crystal, in particular, *demands* this protection because of its delicate internal structure. Similarly, the "spanking" action of a high-speed hull imparts low-frequency shock of high amplitude such as might be experienced in a "rough-landing" with a model aircraft. These factors indicate operational reliability will be only as good as the installation. Be particular and careful and this system's inherent reliability will deliver long life and faultless operation.

ELECTRICAL AND MECHANICAL ALIGNMENT

The following section deals with the "Settting-up" operation of matching transmitter to the receiver/servo combination. This operation has already been accomplished at the factory and this information should *not* be construed to mean each unit delivered will require this service by the purchaser. On the contrary, we recommend that no attempt be made to alter any adjustments until some experience has been gained with system function in field use. This information is provided primarily for reference, but may be used for any minor adjustment.

Linearity Adjustment

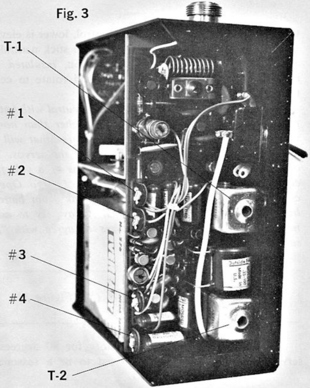
The primary controls, rudder and elevator, utilize 10 K potentiometers. These "pots" are not set at mid-range but off toward one end. The location of the pot wiper with respect to stick neutral position determines proper linearity of servo travel. This will be noted as more servo travel in one direction than the other. For instance, if the servo has greater arc of travel to the right than left, loosen the set-screw on the rudder pot shaft, and using the slot in the pot shaft for adjustment, rotate the shaft *slightly* further to the *right*. Retighten set-screw before operating control to view results of adjustment. Because servo neutral will now be off-center, rotate rudder trim pot to *center the servo,* and check for linearity of throw. Continue in this fashion until satisfied with results.

Opposite rotation of pot shaft would be necessary for a non-linear action in reverse of conditions described. This method also applies to any necessary adjustment to elevator. Assuming that any adjustments have been made, according to these directions, servo neutral would require the appropriate trim pot to be off-center.

Neutral Adjust *(See Figure 3)*

On the lower portion of the printed circuit (transmitter) board are two large metal-enclosed transformers. These transformers have slug-tuned cores, which when rotated, vary the audio tone, causing servo to shift one way or the other depending on direction of slug rotation. The upper

Fig. 3



transformer (T-1) is rudder tone control, lower is elevator (T-2). If servo neutral is off-center with stick neutralized and trim-pot centered, insert a hexagon, *insulated* tuning wand into the appropriate slug and rotate to center the servo.

CAUTION: Do not check for servo neutral with battery pack fresh from charge. There is a higher than normal voltage peak on batteries fresh from charge that will dissipate rapidly after a few operations of the servos. This over-voltage peak may vary a few tenths of a volt from cell to cell, causing a slight neutral shift of servo. Operate controls a few minutes to take this peak from batteries before attempting any adjustments. Always try to adjust neutral postion of control surfaces to agree with "fail-safe" neutral.

Setting the Servo Throw *(See Figure 3)*

Servos are adjusted at the factory for 90 degrees of servo-wheel travel. This has proved to be a reasonable optimum based on sensitivity of control, and adequate push-rod travel. It is possible to increase or decrease this degree of rotation by resetting of the four small trimming potentiometers mounted on the edge of the transmitter P/C board. Each of these small trim pots is paralled across one of the four control pots, namely, rudder and rudder *trim;* elevator and elevator *trim*. Their function is that of setting the maximum resistance change of the primary control potentiometer. By rotating the trim pot wiper *clockwise* (increasing resistance) the control range of the primary control pot is *increased*. Counter-clockwise rotation of the trim pot (lowering resistance) reduces range of control.

Each time one of these trim pots is changed, the neutral position of the servo will change also, necessitating resetting of the slug in the appropriate oscillator transformer. Referring to Figure 3, the potentiometer numbered #1 is used to set range on Rudder control. #2 is Rudder *trim,* #3 is elevator *trim,* and #4 is elevator. Control range for throttle control is factory set and should not be altered. If any of these trim potentiometers are set fully counter-clockwise at the factory they are adjusted for maximum available control travel. Any re-adjustment of this trim pot would then simply decrease control travel.

GENERAL INFORMATION

Specifications

RECEIVER:

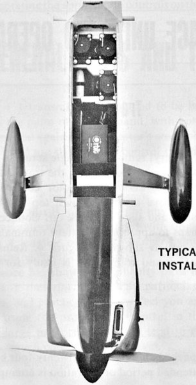
Receiver Size	1-13/16″ x 2-11/16″ x 1-11/16″
Weight	5.25 ozs.
Volts Required	5 volts (4 nickel-cadmium cells in series center-tapped)
Current	40 ma. (receiver only)
Current	110 ma. (nominal on entire system)
Airborne Weight	17 ozs. (receiver, pack and 3 servos)

TRANSMITTER:

Size	2-5/16″ x 5-3/8″ x 5-15/16″
Weight	2.5 lbs.
Voltage Required	9V (RCA VS 306 or equivalent)
Current	70 to 75 ma.
Power Consumption	630 to 680 milli-watts, nominal

OPTIONAL:

Optional 600 mah, 10.5V recharable nickel-cadmium transmitter power-pack and recharger.



TYPICAL INSTALLATION

TO PLACE UNIT INTO OPERATION

Transmitter

To install battery; remove the single screw in the center of the narrow flange of the back of the transmitter on the side where the trim knobs and motor control lever are located. Then remove the two screws, top and bottom on the opposite side, and slide the back off. Connect the male and female snaps to appropriate battery terminals and slide battery into place as shown in Figure 4. Reinstall transmitter back cover and transmitter is ready for operation.

Receiver

Receiver pack should be given a twenty-four hour charge before any extended period of operation is attempted. There

Fig. 4

is sufficient activity in batteries as supplied to operate system for a short while.

Note that all servo leads are color-coded with plastic sleeving to mate into corresponding slots in master block from receiver. Control functions by color are:

Yellow—Elevator
Green—Motor
Brown—Rudder-aileron

The four pin plugs and mating sockets in master block are keyed by one pin being wide-spaced to prevent plugging servo in backwards. However, always check visually as this operation is performed. It *is* possible to gain a partial engagement of plug backwards by excessive force. This condition will cause the servo to run in a continuous circle as power is applied.

Mate all servos into their corresponding slots in master block, and the six-pin power plug into mating socket from battery pack. Apply power by turning on switch that is wired in the leads from pack. At this time, all servos will seek neutral, and motor control servo will run to "Fail-safe" position. Now switch transmitter "ON." Some degree of change in servo position may now be noted, depending on the position of rudder and elevator trim controls and throttle selector lever. You may now observe servo response and travel by operating the appropriate controls on the transmitter.

GENERAL HINTS AND TIPS

The 3 + 1 transmitter is designed to be held, or rather *cradled,* in the palm of the left hand, with bottom of transmitter supported against the operator's stomach. The fingers of the left hand are then free to control the trim knobs and advance and retard the throttle lever. The right hand remains on the control stick. Because this system is fully simultaneous, it is possible to operate *ALL* controls at the same time, but this is, of course, not physically practicable. For those operators not experienced with single-stick flying, we suggest a lengthy period of "hanger-flying" to become familiar with the "feel" of this unit.

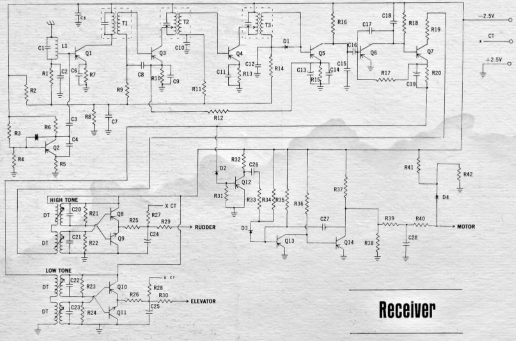
Experience has shown the difficulty most new operators have in using the *trim* knobs. Pay particular attention to this feature, and practice until you feel you are reasonably certain of using the proper trim control in the proper direction. A large proportion of users tend to rig their ships with far too much control surface travel.

In rigging the airplane, try for a slightly more forward

Center-of-Gravity position than is normally used. This will tend to soften any extreme of elevator reponse and lessen the possibility of a condition described as PIO (Pilot Induced Oscillation) wherein the inexperienced pilot with an overly sensitive ship will find himself over-controlling continuously through a series of wild up and down oscillations that terminate in the inevitable crash.

The more forward C.G. location is also beneficial on landing approach, because new proportional pilots tend to flare the airplane too much and too soon on final approach. With C.G. further forward, there is less likelihood of a "stally" approach blooming into an incipient snap-roll into the deck.

The final word of advice is to train with an airplane whose general trim condition is already known. This will preclude the possibility of difficulty that may be experienced with a new and possibly badly out-of-trim ship. If possible, enlist the aid of someone experienced with flying this type of control system. Remember there is nothing comparable to experience.



Receiver

mp65402-1-365 TP

RECEIVER PARTS LIST

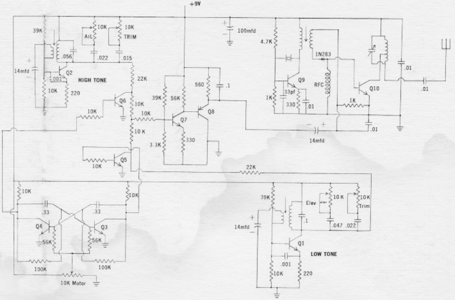
C1	22 pfd
C2	.05 mfd
C3	4.7 pfd
C4	22 pfd
C5	.05 mfd
C6	.22 mfd
C7	.22 mfd
C8	.05 mfd
C9	.22 mfd
C10	.05 mfd
C11	.22 mfd
C12	.1 mfd
C13	25 mfd @ 6V electrolytic
C14	.22 mfd
C15	.2 mfd
C16	.2 mfd
C17	.005 mfd
C18	.05 mfd
C19	14 mfd @ 10V electrolytic
C20	.047 mfd
C21	.047 mfd
C22	.1 mfd
C23	.1 mfd
C24	65 mfd @ 10V electrolytic
C25	65 mfd @ 10V electrolytic
C26	.1 mfd
C27	.1 mfd
C28	65 mfd @ 10V electrolytic

R1	2.2K
R2	22K
R3	10K
R4	3.3K
R5	1K
R6	1K
R7	3.3K
R8	10K
R9	1K
R10	3.3K
R11	1K
R12	220 Ω
R13	2.2K
R14	1K
R15	1.8K
R16	680 Ω
R17	10K
R18	1.8K
R19	470 Ω
R20	220 Ω
R21	18K
R22	18K
R23	18K
R24	18K
R25	330 Ω
R26	330 Ω
R27	4.7K
R28	4.7K
R29	1K
R30	1K
R31	3.3K
R32	1K
R33	220 Ω
R34	27K
R35	22K
R36	4.7K
R37	2.2K
R38	39K
R39	2.2K
R40	1K
R41	2.2K
R42	2.2K

Q1	T 6058 PNP
Q2	T 6058 PNP
Q3	TI 364 PNP
Q4	TI 364 PNP
Q5	TR 970 PNP
Q6	TR 970 PNP
Q7	TR 970 PNP
Q8	TR 970 PNP
Q9	2n 1308 NPN
Q10	TR 970 PNP
Q11	2n 1308 NPN
Q12	TR 970 PNP
Q13	TR 970 PNP
Q14	TR 970 PNP

D1	1N283
D2	1N464
D3	1N283
D4	1N283

L1	1/4 inch diameter form-slug tuned 12 3/4 turns. Tap at 4 3/4.
T1 T2 T3	Radio Industries #12282. No internal capacitor. T1 & T2 use 120 pfd. T3 uses 100 pfd silver mica caps.
DT	(4 ea.) Special discriminator transformer. Available only from Orbit Electronics.



Transmitter

Q1 through Q7 — S7209NPN
Q8 — TR970PNP
Q9 and Q10 — S7210NPN

Orbit ■ ORBIT ELECTRONICS, INC. 11601 ANABEL AVE., GARDEN GROVE, CALIF.